Mathematics | Proposed Calculus (+)

The standards listed in this section are proposed to be included in the Kentucky academic standards for mathematics, in addition to the (+) standards listed in the original standards document and they would NOT be required for all students as part of the minimum high school graduation requirements.

	Domain	Cluster	Standards
Functions, Graphs and Limits	Limits of Functions (F-L)	Understand the concept of the limit of a function.	1. Understand limits and apply the definition of a limit to a variety of functions, including piece-wise functions. 2. Demonstrate an understanding of limits by estimating and finding the limit of a function at a point using graphs, tables and algebra. 3. Apply properties and theorems of limits. 4. Use understanding of limits to communicate solutions of problems using precise mathematical symbols and language.
	Behavior of Functions (F-B)	Describe the asymptotic and unbounded behavior of functions.	1. Describe asymptotic behavior (analytically and graphically) in terms of infinite limits and limits at infinity. 2. Discuss the end behavior of functions; identify prototypical functions for each type of end behavior. 3. Understand, analyze and use characteristics of functions, including polynomial, radical, rational, piece-wise, power, exponential, and logarithmic functions, to solve application problems using mathematical symbols and language.
	Continuity (F-C)	Develop an understanding of continuity as a property of functions	1. Understand and us the limit definition of continuity to determine whether a given function is continuous at a specific point.. 2. Define and determine different types of discontinuity (point, hole, asymptote) in terms of limits. 3. Apply the Intermediate Value Theorem and Extreme Value Theorem to continuous functions. 4. Use understanding of continuity to effectively communicate solutions of problems using precise mathematical symbols and language.

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Derivatives	Understanding the Concept of the Derivative (D-UD)	Demonstrate an understanding of the derivative	1. Define the derivative of a function at a point as the limit of a difference quotient and as understand it as an instantaneous rate of change and as the slope of the tangent line to the function at that point. 2. Use average rate of change to estimate the derivative from a table of values or a graph. 3. Understand the derivative as a function. 4. Apply the definition of derivative to find derivative values and derivative functions. 5. Explain why differentiability implies continuity yet continuity does not imply differentiability.
		Apply the Derivative	6. Use derivatives to analyze curves and optimize values. 7. Understand and apply the Mean Value Theorem, including numeric, algebraic, and graphical representations. 8. Understand the relationship of concavity to the second derivative 9. Understand Rolle's Theorem as a special case of the Mean Value Theorem.
	Computing and Applying Derivatives (D-AD)	Apply differentiation techniques	1. Quickly find derivatives of functions, including linear, quadratic, polynomial, exponential, logarithmic, trigonometric, square root and other root functions. 2. Understand and use derivative rules for sums, differences, products and quotients of two functions and calculate the derivative of a composite function using the chain rule. 3. Use Implicit differentiation to find a derivative in an equation of two variables. 4. Use implicit differentiation to find the derivative of the inverse of a function.
		Use first and second derivatives to analyze a function	5. Understand the relationship of increasing and decreasing behavior to the first derivative. 6. Use the first derivative to find relative and absolute extrema and analytically locate the intervals on which a function is increasing, decreasing or neither. 7. Understand the relationship of concavity to the second derivative. 8. Use the second derivative to find points of inflection. 9. Use the second derivative to analytically locate intervals on which a function is concave up, concave down or neither. 10. Describe how graphical characteristics of a given function, the first derivative of that function, and the second derivative of that function interrelate. 11. Translate verbal descriptions into equations involving derivatives and vice versa.
		Apply derivatives to solve problems	12. Understand the role of rate of change and slope as it applies to the use of the derivative for solving relevant application problems. 13. Understand and be able to calculate the instantaneous rate of change as the limit of the average rate of change and use it to analyze curves, optimize values, and model rates of change in applied contexts. 14. Understand the use of derivatives in solving problems involving separable differential equations and apply this knowledge to solve a variety of problems including related rates, optimization, tangent line approximations (local linearization) and growth and decay models. 15. Use differentiation to solve problems involving velocity, speed, and acceleration. 16. Solve separable differential equations and use them in modeling real-world problems with and without technology. 17. Use understanding of derivatives to effectively communicate solutions of problems using precise mathematical language and notation.

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Integrals	Understanding Integrals (I-UI)	Demonstrate understanding of a Definite Integral	1. Understand the definite integral of a function over an interval is the limit of a Riemann sum over that interval and therefore, interpret a definite integral as a limit of Riemann Sums and as net accumulation of change. 2. Write a Riemann sum that represents the definition of a definite integral. 3. Calculate the values of Riemann Sums over equal subdivisions to approximate definite integrals of functions represented graphically, numerically, and by tables of values. Use left-hand sums, right-hand sums, and trapezoidal sums.
		Understand and apply the fundamental Theorem of Calculus	4. Recognize differentiation and anti-differentiation as inverse operations. 5. Understand how the Fundamental Theorem of Calculus connects differentiation and integration and use it to evaluate definite and indefinite integrals and to represent particular antiderivatives. 6. Perform analytical and graphical analysis of functions using the Fundamental Theorem of Calculus. 7. Understand and use the definite integral of a function over an interval and understand its use as a mathematical tool.
	Calculating and Applying Integrals (I-AI)	Apply techniques of antidifferentiation	1. Quickly find antiderivatives that follow directly from derivatives of basic functions (power, exponential, logarithmic, and trigonometric) and apply basic properties of definite integrals (e.g. additive, constant multiple, translations). 2. Use substitution of variables to find antiderivatives (including changing limits for definite integrals). 3. Find specific antiderivatives using initial conditions.
		Apply integrals to solve problems	4. Model, solve, and interpret applications of antiderivatives including finding area, velocity, acceleration and volume of a solid. 5. Use integrals to solve a variety of problems (e.g., distance traveled by a particle along a line, exponential growth/decay). 6. Use understanding of integral calculus to effectively communicate solutions of problems using precise mathematical language and notation.